THE COMPARATIVE VARIABILITY OF THE SEXES AT BIRTH

HELEN MONTAGUE
New York City

AND

LETA STETTER HOLLINGWORTH
New York City

INTRODUCTION

The discussion of the comparative variability of the sexes began, somewhat vaguely, about a century ago, and bore on anatomical traits. The anatomist Meckel concluded, on pathological grounds, that the human female showed greater variability than the human male, and he thought that, since man is the superior animal, and variation a sign of inferiority, the conclusion was justified. Burdach and other anatomists declared the male to be more variable, and Darwin was led to conclude that among animals the male is more variable. Variation was now no longer regarded as a sign of inferiority, but as an advantage and a characteristic affording the greatest hope for progress. More recently greater mental variability has been inferred from alleged greater anatomical variability, and social significance has been attached by men of science to the comparative variability of the sexes. It has been stated that woman represents the static and conservative element in civilization, while man represents the dynamic and variable element—and that this accounts for the fact that nearly all historical achievement has been the achievement of men. It is further indicated that in the future, as in the past, in spite of any changes that may be wrought in the economic and social status of women, men will always lead women intellectually, because they are inherently more variable.

Prolonged reflection on this matter, and careful study of all available evidence lead to the conclusion that the data at present collected are inadequate for the formulation of any positive

statement as to the comparative variability of the sexes. The data are inadequate because relatively few anatomical units have been measured and because the measurements include too few cases, and have in most instances been treated without sufficient mathematical insight, and are almost never presented in their entirety so as to admit of proper and complete criticism. It is even true that comparison has been made uncritically of data taken from groups of unequal homogeneity. Comparisons have also been made where the number of males was unequal to the number of females, with no allowance for the fact that in such a case results of unequal reliability are obtained, which renders them incomparable. There has also been little or no agreement as to what material should be treated, or what statistical method should be used in determining comparative variability. Thus the mass of evidence and theory that has accumulated on this subject is contradictory, incoherent, and unstandardized. Yet men of science have not restrained themselves from saying that "woman is less modified than man and presents less variation. . . . . Man, on the other hand, represents variation";[1] "Women are nearer to the average type. The extreme variations above and below the average occur more frequently with men."[2] "The greater variability found for males is a sign of the trustworthiness of . . . . data."[3]

In view of the importance of the social differences implied by a difference in variability between the sexes, it seems to us that exact and adequate data should be collected, and as a contribution to this end we have made this study. We have been so hampered in our attempts fully to understand and properly to compare previous work with our own, on account of the failure of authors to present their data in full, that we have kept in mind as one of our chief aims the presentation of all data in such a form that they may be compared in detail with all subsequent work. Also they may be retreated mathematically by anyone who wishes to apply different statistical methods.

[1] G. T. Patrick, "In Quest of the Alcohol Motive," *Popular Science Monthly* (September, 1913).

[2] Hugo Münsterberg, "*General Psychology*," 1914.

[3] E. L. Thorndike, *Educational Psychology* (1910), p. 45.

The data on which this study is based were obtained from the obstetrical histories of the New York Infirmary for Women and Children, in New York City.

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PREVIOUS LITERATURE OF THE SUBJECT

Since the material upon which the present study is based consists of measurements of infants at birth, the literature to which we have found occasion to refer falls quite distinctly into two classes: (1) obstetrical and pediatric, the contribution of the medical profession, and (2) theoretical and statistical, the contribution of mathematicians, sociologists, and educators. These two literatures differ from each other in point of departure, general purpose, and main interest in such a way that it seems desirable to divide them under two headings for purposes of discussion.

1. *Obstetrical and pediatric.*—Members of the medical profession have measured infants for the purpose of determining norms and of adding to the criteria of obstetrical prognosis. They have not been interested in variation, nor in the social implications of their measurements. Hence in their writings we find only *averages*, never figures indicating variability.

The first attempt to measure infants scientifically was made by Roederer[1] in 1753. Among 27 newborn children he found 18 males and 9 females. He found the average weight of the males to be 6 lbs. 9 oz.; that of the females to be 6 lbs. 2 oz. 2 dr. The average length of the males was $20\frac{1}{3}$ inches; that of the females, $19\frac{17}{18}$ inches.

Joseph Clarke[2] writing in 1786, reported measurements on 20 males and 20 females. He took weight, circumference of the head and "dimension from ear to ear." His figures, when averaged are as given in Table A.

[1] Roederer, "De pondere et longitudine infantum recens naturum," *Commentaries of the Royal Society of Göttingen* (1753).

[2] Joseph Clarke, "Observations on Some Causes of the Excess of the Mortality of Males above That of Females," *Philosophical Transactions* (1786).

Pfannkuch[1] later published a much more elaborate study of infants at birth, using in all 714 infants—372 males and 342 females. He dealt with weight, length, and circumference of head. He correlated the average size of head and average length with weight and found a positive correlation, i.e., the heaviest infants were the longest, on the average, and had the largest heads; the lightest infants were the shortest, on the average, and had the smallest heads. He did not, however, work out any coefficient of correlation. Average length and size of head increase from smallest to largest infants only about one-fourth or one-sixth, while weight doubles. Pfannkuch fails to give any definite idea of variation among the infants. His tables do show, however, that the mode for both males and females falls between 3,000 and 3,500 gm. Among the 714 infants he found

TABLE A

Sex	Weight	Circumference of Head	Dimension from Ear to Ear
Males	7 lbs. 5 oz. 7 dr.	14 inches	$7\frac{1}{4}$ inches
Females	6 lbs. 11 oz. 6 dr.	$13\frac{5}{8}$ inches	$7\frac{2}{9}$ inches

11 males and 12 females between 1,500 and 2,000 gm., and 9 males and 4 females between 4,000 and 4,500 gm. In length the mode for males falls at 49.01 cm.; for females, at 48.48 cm. These figures agree very closely with our findings.

Among modern obstetricians and pediatricians both Williams[2] and Holt[3] have published measurements of infants at birth. These will be referred to specifically later, as will also the measurements made by Riggs[4] at Johns Hopkins University.

2. *Theoretical and statistical.*—The greater part of the literature that preceded Pearson may be mentioned here only to be dismissed from consideration, except as being of some interest historically. This is the case for two reasons: first, we assume with Pearson the principle that the comparative variability of the sexes ought

[1] W. Pfannkuch, "Über die Körperform der Neugeborenen," *Arch. f. Gynäk*, Bd. IV.

[2] J. W. Williams, *Obstetrics* (1912 ed.).

[3] L. E. Holt, *Diseases of Infancy* (1910 ed.).

[4] T. F. Riggs (see Williams, *op. cit.*).

properly to be tested by normal rather than by pathological variation; second, writers who preceded Pearson treated their data without sufficient mathematical insight, and since they do not give their data in full it is impossible to criticize their conclusions intelligently or to compare them properly with our own. It would seem almost naïve, for example, to enter upon a criticism of the following statement, which has been put forward in all seriousness as evidence of greater male variability: "Exceptional weight in newborn children is most usually found among the males; in France for weights above 3,500 gm. there are 29 boys to only 19 girls."[1] Obviously enough, the preponderance of boys among the heaviest infants is a function of the central tendency, and not of variability at all. Among the lightest infants, girls would be found to preponderate, for girls are on the average about 100 gm. lighter than boys at birth. The author neglects to consider the exceptionally *small* infants, which are quite as important for a study of variation as exceptionally *large* infants.

Pearson's[2] study to which we here refer appeared in 1897 in the form of a polemical article directed against certain statements made by Havelock Ellis. This controversy is very familiar to students of social science, but since a brief review of the issue involved will lead at once to a clear understanding of the theoretical and social implications of variability, it will be convenient to rehearse the main points here.

Ellis,[3] in a chapter on "The Variational Tendency of Men," discusses certain anatomical and pathological data which show, on the whole, according to the scientific method of that time, the greater variability of the male. He concludes with the following statement:

> Yet there are certain conclusions which have again and again presented themselves, even when we have been occupied in considering very diverse aspects of the physical and psychic phenomena of human life. One of these is the greater variability of the male; this is true for almost the whole of the field we have covered, and it has social and practical consequences of the widest significance. The whole of our human civilization would have been a different

[1] Havelock Ellis, *Man and Woman* (1909 ed.).

[2] Karl Pearson, *Variation in Man and Woman*. See *Chances of Death* (1897).

[3] H. Ellis, *op. cit.*

thing, if in early zoölogical epochs the male had not acquired a greater variational tendency than the female.

Ellis[1] further states: "From an organic standpoint, therefore, women represent the more stable and conservative element in evolution."

Pearson[2] declared the purpose of his article as follows:

> The object of this essay is to lay the axe to the root of this pseudo-scientific superstition. It will not be necessary to prove that the male is either more or less variable than the female, but merely to show that when the proper statistics are considered and are dealt with scientifically there is no evidence to show a preponderating variability in man.

He approached his problem through the following questions: (1) What are the most suitable organs or characteristics for measuring the relative variability of man and woman? (2) How is variability to be scientifically measured?

Before Pearson no one seems to have propounded these questions precisely and intelligently. The mass of evidence and of quotations cited by Ellis is, as has already been indicated, unstandardized and incoherent. One anatomist states that color-blindness is more frequent in males; therefore they are more variable. Another points out that schoolgirls, when bad, are much worse than boys; therefore girls are more variable. It is found by certain statistics that male infants have larger brains than female infants; therefore their greater variability is confirmed, etc.

Pearson answered his first question by concluding that relative variability might most appropriately be tested by normal rather than by pathological variation, pointing out incidentally that the mere *frequency* of a pathological condition is no more valid as a measure of variability than is the degree or *intensity* of the pathological condition. He answered his second question by a mathematical demonstration of the fallacy involved when the absolute variation, i.e., A.D. (average deviation) or S.D. (standard deviation) is taken as the measure of variability; for in this case we know a priori that the group having the highest central tendency will always tend to have the largest absolute A.D. or S.D. For instance, if we wished to determine the comparative variability of infants and adults in respect to length, we should know a priori that adults

[1] H. Ellis, *op. cit.*

[2] K. Pearson, *op. cit.*

would have the greater absolute variability, because adults differ from each other in feet, while infants differ only in inches. Yet infants may really be much more variable than adults. To overcome this effect of greater size on absolute variability Pearson devised a relative measure as the scientific measure of variability, i.e., $\frac{\text{A.D. or S.D.}}{\text{C.T. (central tendency)}}$, and the result thus obtained is now generally known as the Pearson Coefficient of Variation.

Proceeding in this fashion to measure normal variation relatively, Pearson[1] arrived at the following results:

> If we accept as a possible or indeed probable measure of significant variation the so-called coefficient of variation, i.e., the percentage variation for cases in which the sexual means differ considerably, and the standard deviation for cases in which the means are practically identical, then there is in the material considered in this paper—and it appears to represent more cases of normal variation than have hitherto been treated quantitatively—no evidence of greater male variability, but rather of a slightly greater female variability.
>
> Accordingly the principle that man is more variable than woman must be put on one side as a pseudo-scientific superstition until it has been demonstrated in a more scientific manner than has hitherto been attempted.

Thorndike[2] has contributed to the literature of method the proposal that the relative measure of variation should be $\frac{\text{A.D. or S.D.}}{\sqrt{\text{C.T.}}}$, for this seems to him "more in accordance with theory as well as with facts" than Pearson's assumption that the A.D. varies directly as the C.T.

The doctrine of greater male variability has found ready and uncritical acceptance at the hands of scientific men as well as of general writers. The following quotations illustrate very well this widespread credence:

> It is a universal law of animal life that, owing to sexual selection and other causes, the males of a species vary considerably more than the females.[3]
>
> As a general rule, in the evolution of the human race, as well as of the lower races, the female is less subject to variation and is more constant to, and conservative of, the type of the race than the male.[4]

[1] K. Pearson, *op. cit.*

[2] E. L. Thorndike, *Empirical Studies in the Theory of Measurement* (1907), p. 9.

[3] J. Jacob, *Studies in Jewish Statistics* (see Pearson, *op. cit.*).

[4] Edward Carpenter, *Woman* (see Pearson, *op. cit.*).

> We may understand not only the increased desire for alcohol in modern life but also the lesser need for it on the part of women. Woman is less modified than man and presents less variation. Her life is calmer and more even. She is more conservative, representing the child type, which is the race type. . . . . Man, on the other hand, represents variation. The mental powers peculiar to advancing civilization are more developed in him.[1]

It would not seem proper to close a discussion of the literature of this subject without reference to Darwin's statements about male variability, for it is on his authority that many lesser writers have based their credence. In his study of domesticated animals he arrived at the conclusion that males are more variable, basing his conclusion on the development of secondary sexual characteristics. As to variation in human beings, Darwin[2] remarked the fact that polydactylism seems to be more common in males, but Pearson[3] thinks that wider statistics will disprove this.

AIM, MATERIAL, AND METHOD OF THE PRESENT STUDY

Aim.—The present study was conceived and formulated to answer the following question: *Are male human beings inherently more variable in anatomical traits than female human beings?*

Material.—The first question that arises when this problem comes under consideration is: What *material* is most likely to furnish a reliable solution? Pearson[4] concluded that normal rather than pathological data should be considered, and he worked upon normal material, though fully realizing the difficulty of drawing the line between normal and pathological, or of exactly defining these terms. We have adopted this same plan, and for the same reasons that led Pearson to adopt it. Pearson's material, however, consisted for the most part of measurements of adults, or of children old enough to have been somewhat influenced by the great differences in training and social attitudes to which boys and girls are subject. His results, therefore, show not so much the *inherent* variability of the sexes as the variability of males and females *as*

[1] G. T. W. Patrick, *op. cit., Popular Science Monthly* (September, 1913).

[2] Charles Darwin, *Descent of Man* (1874).

[3] Karl Pearson, *op. cit.*

[4] *Op. cit.*

we find them in the world. Ellis,[1] in replying to Pearson's article, notes this fact as follows:

> Even if we admit that size at birth constitutes a sound test—and this cannot be admitted without qualification, as we shall soon see—it is evident that the comparative variation of the sexes in this respect is liable to be affected by environmental circumstances as age increases. The influences of life differently affecting and exercising the two sexes, the influence of death probably exerting an unequal selective influence—both alike must be allowed for if this kind of evidence is to be regarded as a test of the first rank of importance. Otherwise we are not dealing with the incidence of variations at all, but with the eliminations—an altogether different matter.

This criticism is just if we are attempting to solve the problem of inherent variability. The lives of men and women are lived under conditions so different as to constitute practically different environments. We cannot say what effect this difference in life-habits might have upon the original variability of males and females. Pearson[2] himself thought that we should expect a priori a greater variability among women, because the struggle for existence is not so strenuous among them as among men, and for this reason variations would not be so likely to be cut off. We should be inclined to take the opposite view,[3] i.e., that a priori we should expect to find adult males more variable than adult females, because the males are free to follow a great variety of trades, professions, and industries, while women have been confined to the single occupation of housekeeping, because of the part they play in the perpetuation of the species. Thus variability has had comparatively little survival value for women. A woman of natural herculean strength does not wash dishes, cook meals, or rear children much more successfully than a woman of ordinary muscle. But a man of natural herculean strength is free to abandon carpentry or agriculture and become a prize fighter or a blacksmith, thus exercising and enhancing his native equipment.

Measurements of infants at birth, however, are not open to these objections, for infants have not as yet been exposed to different environments. Ellis,[3] nevertheless, objects to the validity of these

[1] H. Ellis, *op. cit.* [2] K. Pearson, *op. cit.*

[3] Leta S. Hollingworth, "Variability as Related to Sex Differences in Achievement," *American Journal of Sociology*, XIX (1914), 510.

data, on the ground that the process of birth itself affects the sexes unequally. Since males are, on the average, slightly larger than females, he says that theoretically the selective influence of the pelvis will more often act upon the males, eliminating the very large infants, more of which are males, and thus limiting the variability of males more than the variability of females on the side of great size.

Now, there are two pertinent comments to be made with regard to this criticism on the validity of measurements of infants at birth. In the first place, as Ellis[1] himself admits, there is no sufficient evidence as yet adduced to confirm the theory that more large males than large females are eliminated. In the second place, Ellis does not sufficiently regard the fact that the organism is free to vary as far as it inherently can on the side of *smallness;* and if males are more variable, we shall expect to find them in preponderance among the exceptionally *small* infants also, since there is no reason whatever for supposing that males vary from their mode in one direction only, i.e., in the direction of great size.

If Ellis rejects the validity of measurements at birth, by that rejection he acknowledges the utter unreliability of *all* that is contained in his chapter on "The Variational Tendency of Men," and declares the impossibility of attacking the problem at all. For all anatomical measurements are rendered invalid by the fact that birth, life, and death affect the sexes unequally; all mental measurements are rendered invalid twice over for the same reason; and pathological data are certainly invalid, because there is every reason to suppose that the frequency and intensity of pathological conditions may be greatly affected by differences in habit and environment such as obtain in the case of men and women, and that pathological conditions are positively correlated with such factors as size of head, weight, etc., and would suffer elimination in exactly the same way as other variations.

While recognizing the weight of all these objections, and the necessity of keeping in mind all the many sources of error, it still seems clear that a proper consideration of a great number of infants at birth will yield valid information on the subject of the compara-

[1] H. Ellis, *op. cit.*, Appendix.

tive inherent variability of the sexes in anatomical traits. When a large number of male infants and a large number of female infants, each group equal in number, unselected, and equally heterogeneous with respect to race and class, are distributed, the following phenomena should appear, if the males are inherently more variable: (1) there should be a more abrupt drop of the curve representing the males, at the extreme of great size, to indicate a greater pelvic selection of large males than of large females; (2) there should be a preponderance of males at *both* extremes of the distribution—the smallest as well as the largest infants should be males, since (*a*) there is no pelvic selection on the side of smallness, (*b*) there is no reason to suppose that males vary from their mode in one direction only, and (*c*) the difference in central tendency between the sexes is insignificant.

The material upon which the present study is based consists of 20,000 measurements of infants at birth. The measurements were made at the New York Infirmary for Women and Children, where 10 anatomical measurements are made on every infant born in the obstetrical wards. These measurements are weight, length, circumference of shoulders, and 7 cranial measurements—bi-temporal, occipito-frontal, bi-parietal, occipito-mental, sub-occipito-bregmatic (diameters), occipito-frontal and sub-occipito-bregmatic (circumferences). These measurements are made immediately after birth, before the infant has ingested any food. The weight is taken on a beam scale, measuring in grams. Length, circumference of shoulders, and the cranial circumferences are measured with a metal tape measure. The cranial diameters are measured with a pelvimeter.

This was the method of securing the measurements which are used for the present study. The investigator began in the files with the last infant born and proceeded to transcribe from the records the measurements of 1,000 consecutive males and 1,000 consecutive females. This took the investigator back through about three and one-half years, since about 600 infants are born in this hospital every year. Premature infants, syphilitic infants, and twins were excluded, but such exclusions were made only when the child's record *definitely stated* that it was *premature*, *syphilitic*, or a

twin. Pearson took only "full-term children of married mothers." He says nothing about twins or the syphilitic. Presumably, therefore, he included them. We, like Pearson, have included only full-term children, but, unlike him, we have made no note of legitimacy or illegitimacy. In the absence of any proof to the contrary we assume that illegitimate offspring are as likely to be of one sex as of the other. This would also hold true for premature, syphilitic, and twin infants, as far as we know; hence the inclusion of these would not invalidate a *comparison* of the two sexes. Nevertheless, after careful discussion, it seemed best to exclude those which were definitely recorded as pathological or born in an unusual condition, since we are avowedly considering the *normal* distribution. The question as to whether twins should be excluded provoked the greatest amount of discussion, since the condition of being a twin cannot properly be described as pathological. In the course of transcribing the records of 2,000 infants we found 18 pairs of twins,[1] of which 24 individuals were females and 12 individuals were males. There are many extremely small infants among these twins, and since there were found twice as many females as males, it seemed best to exclude them.

The infants were extremely heterogeneous with respect to race, as is naturally the case in a hospital situated on the lower East Side of New York City. Almost every nationality is represented, with Hebrews, Italians, and Slavs predominating. There are very few Negroes, Turks, or Asiatics included. On the other hand, the infants were very homogeneous with respect to *economic class*, there being very few from the economically well-to-do classes.

In addition to the objections already discussed, the following specific objections to this material might be offered: (1) the weight of newborn infants is to a great extent a function of the nutrition of the mother during gestation; (2) the heads of newborn infants have just been subjected to great pressure, and are often crushed out of their normal proportions; (3) some of the measurements, particularly of the head, should have been taken more exactly than to half a centimeter; (4) the measurements were not all made by

[1] It will be understood here that, since the twins were excluded, the number of infants really transcribed was 2,036. The twins are given separately (see p. 368).

the same person, but, on the contrary, by a succession of physicians; (5) the infants measured were very heterogeneous with respect to race.

The reply to all these objections is that the reliability of the results will depend not only on the accuracy of each individual measurement, but on the number of cases as well, and will be practically unaffected by any of the above factors if a sufficiently large number of cases is included. The writers have felt that a thousand cases from each group would be a sufficient number to overcome the effect of all the variable errors due to the circumstances noted above. So far as any reliable knowledge goes at present, all extrinsic prenatal influences are as likely to affect one sex as the other. The child of a particularly ill-nourished mother is, in the long run, as likely to be a boy as a girl. The distortion of the heads, due to pressure in the birth canal, does undoubtedly tend to affect the males more than the females, to the degree in which the former are, on the average, larger than the latter. The fact is, however, that the average difference between male and female heads is, in every measurement, very slight. Furthermore, the validity or invalidity of the results from cranial measurements will be in some degree indicated by their agreement or disagreement with results from measurements of other parts of the anatomy. The large number of cases will tend to bring out what is, in the long run, true. Although the infants were very heterogeneous with respect to race, the two groups were *equally* heterogeneous. An Italian infant or a Greek infant was as likely to be a male as a female. The fact that different persons took the measurements from time to time is of no consequence, since *both* males and females were measured by the same person during that person's term of attendance at the hospital.

Method.—The statistical procedure was as follows: Each of the ten variables (dimensions, traits, measurements) was distributed for each sex separately along the steps through which it ranged, and tables of frequency were thus compiled. From each table of frequency the average of the group was found, in the ordinary manner. The *average deviation* (A.D.) of the individual measurements from this average was then computed. Since there is no agreement among men of science or statisticians as to what constitutes the

most satisfactory measurement of comparative variability, and since the present writers are not sufficiently learned in mathematical theory to form a discriminating judgment, all measurements so far proposed, which seem to have a justifiable claim, have been here computed and presented. These are: (1) the gross variation (A.D.), (2) the Pearson Coefficient of Variation $\left(\frac{\text{A.D. or S.D.}}{\text{C.T.}}\right)$, and (3) the Thorndike Coefficient of Variation $\left(\frac{\text{A.D. or S.D.}}{\sqrt{\text{C.T.}}}\right)$. In addition to these figures, the range including 100 per cent of the cases and the unbroken range are given in the final summary.

The last two measurements have been included because, although a greater coefficient of variation *theoretically* implies greater range (if the trait being distributed conforms to the Gauss curve of probability),[1] *empirically* a greater coefficient of variation is not always found to correspond to greater range. And the social significance that has been attached to greater variability attaches especially to the fact of *greater range.*

For reasons set forth in his article, Pearson uses the *standard deviation* (S.D.) instead of the average deviation (A.D.) as a measure of gross variability. Thorndike, in his *Empirical Studies*, arrived at the conclusion that the A.D. constitutes a measure about as reliable as the S.D. and one therefore more practicable, since it is much easier to calculate. We have chosen to use the A.D., but we have presented our data in such a way that anyone who wishes to take the time may compute the S.D. from the original tables of frequency. In order to insure arithmetical accuracy every computation was made twice—once by each of the writers. The monotonous labor of adding was facilitated by the use of the Pike adding machine.

RESULTS OF THE PRESENT STUDY

Weight.—The weight of newborn infants is measured here in steps of 10 gm., and the table of frequency is given in these steps. In plotting the surface of frequency, however, the measurements have been combined into steps of 50 gm. It will be noticed at once

[1] This is by no means proven to be the case with our measurements.

that there was some tendency on the part of the physicians who took these measurements to group the infants at the even hundreds and at the fifties. This error, however, is a variable one (since infants *both* slightly larger and slightly smaller than the even number of grams will be grouped there), and is overcome by the large number of cases. It also affects both sexes *equally*, and hence does not in any way invalidate the *comparison*. Weight is probably the most important measurement to the obstetrician, since the infant is weighed every day while in the hospital to determine normal gain.

Table of Frequency I gives the distribution of the 2,000 infants of the present study in detail. Table B shows the facts with respect

TABLE B

	Sex	Average (gm.)	A.D. (gm.)	Pearson Coefficient of Variation	P.E. of Pearson Coefficient	Thorndike Coefficient of Variation	Range Including 100 Per Cent of Cases	Unbroken Range
Weight	Males	3357.65	397.3824	.1183	.0014	.685	2,030–5,020 (inc.)	(See Table of Frequency I)
	Females	3221.17	381.0768	.1183	.0014	.671	1,960–5,360 (inc.)	

to comparative variability. It is seen that male infants are about 130 gm. heavier on the average than female infants. The male infants have a greater absolute variability (A.D.), as would be expected. The Pearson Coefficient of Variation is exactly the same for both sexes, to the fourth decimal. The Thorndike Coefficient of Variation shows a slight advantage for the males. The range, including 100 per cent of the cases, is greater for females. The lightest infant and the heaviest infant of the 2,000 are both females. The measurements of the largest male and of the largest female are given below in Table C.

TABLE C

Sex	Length	Occ.-front.	Bi.-par.	Bi.-temp.	Occ.-ment.	Sub.-occ.-breg.	Occ.-front.	Sub.-occ.-breg. (Cir.)	Shoulders	Weight
Male.....	56	12	9	7	15	10	36.5	33	37	5,020
Female....	55	12	10	8.5	14.5	11	36	35	45	5,360

TABLE OF FREQUENCY I

WEIGHT (IN GRAMS) OF INFANTS AT BIRTH

Grams	Frequency		Grams	Frequency	
	Males	Females		Males	Females
1,960.......	0	1	2,480......	1	6
1,970.......	0	0	2,490......	1	0
1,980.......	0	0	2,500......	4	5
1,990.......	0	0	2,510......	0	1
2,000.......	0	1	2,520......	1	3
2,010.......	0	0	2,530......	1	2
2,020.......	0	0	2,540......	1	0
2,030.......	1	0	2,550......	3	8
2,040.......	0	0	2,560......	1	0
2,050.......	1	1	2,570......	2	0
2,060.......	2	0	2,580......	0	1
2,070.......	1	0	2,590......	3	1
2,080.......	2	1	2,600......	3	9
2,090.......	0	1	2,610......	0	2
2,100.......	2	1	2,620......	2	4
2,110.......	0	2	2,630......	1	4
2,120.......	2	1	2,640......	2	2
2,130.......	0	0	2,650......	3	11
2,140.......	0	1	2,660......	1	1
2,150.......	2	1	2,670......	2	3
2,160.......	2	0	2,680......	4	2
2,170.......	0	0	2,690......	1	2
2,180.......	1	0	2,700......	5	12
2,190.......	0	1	2,710......	2	3
2,200.......	2	0	2,720......	1	2
2,210.......	0	2	2,730......	4	4
2,220.......	0	1	2,740......	4	3
2,230.......	2	1	2,750......	3	6
2,240.......	0	0	2,760......	1	6
2,250.......	3	0	2,770......	4	4
2,260.......	0	0	2,780......	2	4
2,270.......	0	5	2,790......	3	4
2,280.......	1	2	2,800......	17	10
2,290.......	0	1	2,810......	2	3
2,300.......	1	5	2,820......	10	3
2,310.......	1	0	2,830......	3	1
2,320.......	1	3	2,840......	1	6
2,330.......	0	0	2,850......	5	10
2,340.......	0	4	2,860......	6	1
2,350.......	2	4	2,870......	6	12
2,360.......	0	0	2,880......	5	2
2,370.......	2	1	2,890......	4	3
2,380.......	1	1	2,900......	5	15
2,390.......	1	0	2,910......	5	8
2,400.......	2	7	2,920......	6	7
2,410.......	2	3	2,930......	3	6
2,420.......	0	0	2,940......	4	4
2,430.......	3	1	2,950......	10	10
2,440.......	0	5	2,960......	6	5
2,450.......	2	2	2,970......	4	7
2,460.......	1	2	2,980......	1	5
2,470.......	2	2	2,990......	0	2

TABLE OF FREQUENCY I—*Continued*

Grams	Frequency		Grams	Frequency	
	Males	Females		Males	Females
3,000	16	20	3,520	13	7
3,010	5	5	3,530	4	3
3,020	7	13	3,540	1	3
3,030	8	7	3,550	20	13
3,040	3	8	3,560	3	5
3,050	11	17	3,570	8	5
3,060	10	5	3,580	7	2
3,070	15	5	3,590	4	3
3,080	6	6	3,600	16	16
3,090	5	3	3,610	9	4
3,100	16	22	3,620	6	4
3,110	3	6	3,630	5	4
3,120	8	8	3,640	3	4
3,130	6	2	3,650	7	10
3,140	6	6	3,660	4	5
3,150	15	18	3,670	5	3
3,160	3	7	3,680	4	4
3,170	5	7	3,690	7	2
3,180	5	4	3,700	13	11
3,190	6	4	3,710	3	9
3,200	18	27	3,720	2	3
3,210	2	7	3,730	7	1
3,220	5	14	3,740	3	1
3,230	5	6	3,750	15	9
3,240	8	4	3,760	4	0
3,250	23	14	3,770	8	4
3,260	5	1	3,780	1	5
3,270	5	11	3,790	5	2
3,280	7	4	3,800	13	11
3,290	2	7	3,810	4	3
3,300	12	15	3,820	1	4
3,310	4	7	3,830	1	2
3,320	8	2	3,840	3	4
3,330	7	7	3,850	12	5
3,340	6	4	3,860	4	1
3,350	18	10	3,870	8	2
3,360	7	4	3,880	4	1
3,370	10	8	3,890	2	3
3,380	2	2	3,900	6	7
3,390	4	4	3,910	3	2
3,400	20	13	3,920	4	4
3,410	0	8	3,930	6	1
3,420	5	13	3,940	0	3
3,430	3	4	3,950	12	5
3,440	7	6	3,960	4	2
3,450	21	12	3,970	4	2
3,460	1	7	3,980	5	1
3,470	7	8	3,990	1	4
3,480	1	6	4,000	10	3
3,490	4	4	4,010	1	0
3,500	18	23	4,020	3	2
3,510	2	3	4,030	2	1

TABLE OF FREQUENCY I—*Continued*

Grams	Frequency		Grams	Frequency	
	Males	Females		Males	Females
4,040	2	1	4,560		
4,050	7	4	4,570	1	
4,060	3	1	4,580		
4,070	3	1	4,590		
4,080	0	1	4,600	1	1
4,090	4	0	4,610		
4,100	5	6	4,620		
4,110	1	1	4,630		
4,120	0	0	4,640		
4,130	0	1	4,650		
4,140	0	0	4,660		
4,150	4	4	4,670	2	
4,160	2	0	4,680		
4,170	1	0	4,690		
4,180	2	2	4,700	2	1
4,190	2	1	4,710		
4,200	3	3	4,720		
4,210	0	1	4,730		
4,220	2	1	4,740		
4,230	0	0	4,750	2	
4,240	0	0	4,760		
4,250	1	3	4,770	1	
4,260	2	0	4,780		
4,270	0	1	4,790		
4,280	0	0	4,800		1
4,290	0	0	4,810		
4,300	3	2	4,820		
4,310	1	1	4,830		
4,320	3		4,840		
4,330	0		4,850		
4,340	1		4,860		1
4,350	4		4,870		
4,360			4,880		
4,370			4,890		
4,380			4,900		
4,390			4,910		
4,400	2		4,920		
4,410			4,930		
4,420			4,940		
4,430	1	2	4,950		
4,440	1		4,960		
4,450	3		4,970		
4,460	2		4,980		
4,470	1	2	4,990		
4,480		1	5,000	1	
4,490			5,010		
4,500	1	2	5,020	1	
4,510	0		5,030		
4,520	1		5,040		
4,530	1		5,050		
4,540			5,060		
4,550		1	5,070		

TABLE OF FREQUENCY I—*Continued*

Grams	Frequency		Grams	Frequency	
	Males	Females		Males	Females
5,080	...	...	5,230	...	...
5,090	...	...	5,240	...	...
5,100	...	...	5,250	...	...
5,110	...	...	5,260	...	...
5,120	...	...	5,270	...	...
5,130	...	...	5,280	...	...
5,140	...	...	5,290	...	...
5,150	...	...	5,300	...	...
5,160	...	...	5,310	...	...
5,170	...	...	5,320	...	...
5,180	...	...	5,330	...	...
5,190	...	...	5,340	...	...
5,200	...	...	5,350	...	...
5,210	...	...	5,360	...	1
5,220	...	...			
				1,000	1,000
Average	...	...	...	3,357.65	3,221.17
A.D.	...	...	...	397.3824	381.0768

Our results as to the average weight of infants agree very closely with the results of others. Holt[1] gives the weight of newborn infants as follows:

590 males..........7.55 lbs. (3,400 gm.)
568 females.........7.16 lbs. (3,260 gm.)

Riggs[2] gives the average weight at birth of 707 full-term white children as 3,316.9 gm. This includes both sexes. The smallest among Riggs's infants weighed 2,180 gm.; the largest, 4,553 gm. The sex of these two exceptional infants is not stated. Neither Holt nor Riggs gives any measure of variability.

Weight was the only variable measured by Pearson,[3] in the case of newborn infants. He found the average weight of 861 English male infants to be 3.335 kg., with a percentile variation of 0.1565; for 770 female infants to be 3.225 kg., with a percentile variation of 0.1444. These averages agree very closely with ours, but our coefficients of variation are somewhat smaller than Pearson's. This is doubtless due to our greater number of cases. Pearson concludes

[1] E. L. Holt, *op. cit.*

[2] T. F. Riggs (see Williams, *op. cit.*).

[3] K. Pearson, *op. cit.*

as to comparative variability in weight that Teutonic (English and German) males are more variable at birth than females, but that the reverse holds for Belgian infants.

Williams[1] in discussing exceptional weights in newborn infants remarks that a lighter weight than 2,300 gm. is almost certainly diagnostic of syphilis, while a weight of more than 5,000 gm. is almost certainly the result of prolonged pregnancy. In the case of the infants included here no diagnosis of syphilis had been made by the obstetrician in charge, since all infants diagnosed as syphilitic were excluded. The few infants, therefore, weighing less than 2,300 gm., which are included among our 2,000, are, so far as can be known, normal. It is certainly quite possible for full-term infants weighing less than 2,300 gm. to be born in good health, for it is not uncommon for normal twin infants to weigh less than this. Nor in the cases of infants heavier than 5,000 gm. was there any note of prolonged pregnancy. For our purposes, however, neither of these considerations is of vital consequence, since a syphilitic child or a child born after prolonged pregnancy is in the long run as likely to be of one sex as the other.

There is no abrupt fall of either curve of distribution toward zero on the side of great size to indicate a pelvic selection from that end of the curve. The curves of both sexes follow the same course very closely, and both taper out to thin ends, as does the ordinary normal curve of distribution.

Length.—The length of these infants was measured in centimeters, and it seems probable that this is sufficiently precise, since the error in the process of measuring such a variable as length would conceivably amount to nearly as much as a centimeter. Table of Frequency II gives the total distribution of the 2,000 infants. Table D shows the facts with respect to comparative variability.

TABLE D

	Sex	Average (cm.)	A.D. (cm.)	Pearson Coefficient of Variation	P.E. of Pearson Coefficient	Thorndike Coefficient	Range Including 100 Per Cent of Cases	Unbroken Range
Length	Males	50.51	2.349	.0465	.0006	.330	38–62 (inc.)	40–59 (inc.)
	Females	49.90	2.275	.0456	.0006	.323	35–59 (inc.)	40–59 (inc.)

[1] J. W. Williams, *op. cit.*

Male infants are on the average about six-tenths of a centimeter longer than female infants. Males have a very slightly larger gross variation than do females. According to both the Pearson Coefficient and the Thorndike Coefficient there is no reliable difference in variability. The range, including 100 per cent of the cases, is equal, as is the unbroken range. There are 3 female infants shorter than the shortest males, and 1 male infant longer than the longest females.

TABLE OF FREQUENCY II

LENGTH (IN CENTIMETERS) OF INFANTS AT BIRTH

Centimeters	Frequency		Centimeters	Frequency	
	Males	Females		Males	Females
35	0	1	49	96	114
36	0	1	50	158	168
37	0	1	51	136	139
38	1	0	52	130	131
39	0	0	53	103	66
40	1	3	54	75	38
41	5	1	55	30	39
42	2	6	56	24	11
43	5	14	57	10	1
44	10	17	58	5	5
45	32	30	59	2	2
46	47	49	60	0	0
47	40	63	61	0	0
48	87	100	62	1	0
				1,000	1,000
Average				50.51	49.90
A.D.				2.349	2.275

Holt[1] and Riggs[2] give figures on the length of infants at birth, and there is very close agreement among all the findings. Holt found the average length of 231 male infants to be 52.5 cm.; of 211 female infants to be 52.2 cm. Riggs found the average of 707 infants, without respect to sex, to be 49.64 cm.

The dimension of length would not be subject to the limiting influence of the pelvis, except in so far as it is correlated positively with weight and size of skull. It is evident from our figures, as well as from those of Clarke, that a positive correlation between

[1] L. E. Holt, *op. cit.* [2] T. F. Riggs, *op. cit.*

length and other anatomical units does exist. However, there is no pelvic limitation in the direction of *shortness*, and females clearly predominate among the exceptionally short infants, although there is almost no difference between the central tendencies of the sexes. On the other hand, if we eliminate the one male infant showing the exceptionally great length of 62 cm., we find that in the next greatest lengths where any infants occur there are 2 males and 2 females 59 cm. long and 5 males and 5 females 58 cm. long. There is no abrupt fall of the curve of either sex to zero on the side of great length to indicate a selection by the pelvis of the very long infants. The curves follow each other closely, and taper out to thin edges at the ends as in the ordinary normal curve of distribution.

Circumference of the shoulders.—The circumference of the shoulders is measured in centimeters, and, as in the case of length, this degree of precision seems satisfactory for our purposes. Table of Frequency III gives the complete distribution of the 2,000 infants.

TABLE OF FREQUENCY III

CIRCUMFERENCE (IN CENTIMETERS) OF SHOULDERS OF INFANTS AT BIRTH

Centimeters	Frequency		Centimeters	Frequency	
	Males	Females		Males	Females
25..........	0	1	36.........	114	92
26..........	3	1	37.........	74	73
27..........	4	2	38.........	34	39
28..........	14	12	39.........	26	11
29..........	19	20	40.........	8	11
30..........	36	36	41.........	6	2
31..........	51	81	42.........	4	2
32..........	92	123	43.........	1	0
33..........	159	190	44.........	0	0
34..........	198	175	45.........	1	1
35..........	156	128			
				1,000	1,000
Average.....	....	....	....	34.143	33.823
A.D.	....	....	....	1.906936	1.887036

Table E shows the facts with respect to variability. This table shows that males are on the average very slightly larger in circumference of shoulders than females. The A.D. is very slightly larger for males. The variability as measured by the Pearson Coefficient is exactly the same for both sexes, and as measured by the Thorn-

dike Coefficient there is no reliable difference. The range, including 100 per cent of the cases, is greater by 1 cm. for females. There is 1 female smaller than the smallest male; 1 female and 1 male reach the exceptionally great circumference of 45 cm. If we eliminate these two infants, the next largest is a male measuring 43 cm.

TABLE E

	Sex	Average (cm.)	A.D. (cm.)	Pearson Coefficient of Variation	P.E. of Pearson Coefficient	Thorndike Coefficient of Variation	Range Including 100 Per Cent of Cases	Unbroken Range
Circumference of shoulders	Males	34.143	1.906936	.0558	.0007	.326	26–45 (inc.)	26–43 (inc.)
	Females	33.823	1.887036	.0558	.0007	.324	25–45 (inc.)	25–42 (inc.)

Bi-temporal.—The bi-temporal measurement is determined to half a centimeter. It would no doubt be better for our purpose if this measurement had been made in millimeters, since it is so small that half a centimeter is a considerable percentage of the whole amount. However, the figures are of great interest as they stand, and the chances are after all very slight that measurement to a millimeter would reverse the findings with respect to variability. These remarks apply equally to all the diameter measurements of the head.

Table of Frequency IV gives the complete distribution of the 2,000 infants. Table F shows the facts with respect to variability.

TABLE OF FREQUENCY IV

BI-TEMPORAL (IN CENTIMETERS) OF INFANTS AT BIRTH

Centimeters	Frequency		Centimeters	Frequency	
	Males	Females		Males	Females
5	5	11	8	241	245
5.5	7	10	8.5	89	84
6	80	99	9	80	65
6.5	43	66	9.5	24	12
7	255	224	10	7	6
7.5	169	178			
				1,000	1,000
Average				7.558	7.469
A.D.				.71884	.72258

It is seen that males are on the average very slightly larger in the bi-temporal diameter than females. Females have a very slightly greater gross variation, in spite of their slightly smaller central tendency, but according to both the Pearson Coefficient and the

TABLE F

	Sex	Average (cm.)	A.D.(cm.)	Pearson Coefficient of Variation	P.E. of Pearson Coefficient	Thorndike Coefficient of Variation	Range Including 100 Per Cent of Cases	Unbroken Range
Bi-temporal diameter..	Males	7.558	.71884	.0951	.0012	.262	5–10 (inc.)	5–10 (inc.)
	Females	7.469	.72258	.0967	.0012	.264	5–10 (inc.)	5–10 (inc.)

Thorndike Coefficient there is no difference in variability. The range, including 100 per cent of the cases, as well as the unbroken range, is the same for both sexes. At the smallest extreme there are 5 males and 11 females; at the largest extreme 7 males and 6 females

Occipito-frontal (diameter).—Table of Frequency V gives the complete distribution of the 2,000 infants. Table G shows the

TABLE OF FREQUENCY V

OCCIPITO-FRONTAL DIAMETER (IN CENTIMETERS) OF INFANTS AT BIRTH

Centimeters	Frequency		Centimeters	Frequency	
	Males	Females		Males	Females
8.5........	0	2	12.........	225	155
9..........	3	8	12.5.......	55	38
9.5........	3	9	13.........	23	26
10.........	71	105	13.5.......	5	2
10.5.......	70	94	14.........	5	5
11.........	361	397	14.5.......	0	....
11.5.......	178	159	15.........	1	....
				1,000	1,000
Average.....	....	....	....	11.358	11.177
A.D........	....	....	....	.596228	.590710

facts with respect to variability. It is seen that male infants are slightly larger on the average than female infants. Males are

slightly more variable absolutely. According to the Pearson Coefficient and to the Thorndike Coefficient there is no difference in variability. The range, including 100 per cent of the cases, is greater by half a centimeter for males. There are 2 females

TABLE G

	Sex	Average (cm.)	A.D. (cm.)	Pearson Coefficient of Variation	P.E. of Pearson Coefficient	Thorndike Coefficient	Range Including 100 Per Cent of Cases	Unbroken Range
Occipito-frontal diameter	Males	11.358	.596228	.0525	.0006+	.177	9–15 (inc.)	9–14 (inc.)
	Females	11.177	.590710	.0529	.0006+	.177	8.5–14 (inc.)	8.5–14 (inc.)

smaller than the smallest males, and 1 male larger than the largest females. If we eliminate this one male, who reached the exceptional diameter of 15 cm., the next largest infants are 5 males and 5 females, who reached a diameter of 14 cm.

The average measurements of previous writers agree closely with our own (see Table M).

Bi-parietal.—Table of Frequency VI gives the total distribution of the 2,000 infants. Table H shows the facts with respect to

TABLE OF FREQUENCY VI

BI-PARIETAL (IN CENTIMETERS) OF INFANTS AT BIRTH

Centimeters	Frequency		Centimeters	Frequency	
	Males	Females		Males	Females
6..........	1	2	9.........	428	403
6.5.........	2	0	9.5.......	143	132
7..........	13	19	10.........	80	63
7.5.........	34	42	10.5.......	6	3
8..........	122	165	11.........	6	3
8.5.........	164	168	11.5.......	1	....
				1,000	1,000
Average.....	....	....	....	8.886	8.784
A.D........	....	....	....	.501392	.540428

variability. It is seen that male infants are on the average slightly larger than female infants. In spite of this fact females are more

TABLE H

	Sex	Average (cm.)	A.D. (cm.)	Pearson Coefficient of Variation	P. E. of Pearson Coefficient	Thorndike Coefficient	Range Including 100 Per Cent of Cases	Unbroken Range
Bi-parietal...	Males	8.886	.501392	.0564	.0007	.169	6–11.5 (inc.)	6–11.5 (inc.)
	Females	8.784	.540428	.0615	.0008	.182	6–11 (inc.)	6–11 (inc.)

variable absolutely as well as relatively. The range, including 100 per cent of cases, is greater for males by half a centimeter. For a comparison of these results with previous work see Table M.

TABLE OF FREQUENCY VII

OCCIPITO-MENTAL (IN CENTIMETERS) OF INFANTS AT BIRTH

Centimeters	Frequency		Centimeters	Frequency	
	Males	Females		Males	Females
8..........	3	1	12.........	90	115
8.5........	0	1	12.5.......	128	127
9..........	4	3	13.........	277	298
9.5........	4	2	13.5.......	117	119
10.........	12	14	14.........	199	145
10.5.......	22	25	14.5.......	45	25
11.........	38	65	15.........	34	20
11.5.......	26	38	15.5.......	1	1
				1,000	1,000
Average.....	....	....	....	12.99	12.773
A.D........	....	....	....	.80396	.832259

Occipito-mental.—Table of Frequency VII gives the complete distribution of the 2,000 infants. Table I gives the facts with

TABLE I

	Sex	Average (cm.)	A.D. (cm.)	Pearson Coefficient of Variation	P.E. of Pearson Coefficient	Thorndike Coefficient	Range Including 100 Per Cent of Cases	Unbroken Range
Occipito-mental....	Males	12.990	.803960	.0619	.0008	.223	8–15.5 (inc.)	8–15.5 (inc.)
	Females	12.773	.832259	.0651	.0008	.233	8–15.5 (inc.)	8–15.5 (inc.)

respect to variability. Male infants are on the average slightly larger than female infants. Females are slightly more variable, both absolutely and relatively. The range, including 100 per cent of the cases, is the same for both sexes.

Sub-occipito-bregmatic (diameter).—Table of Frequency VIII gives the complete distribution of the 2,000 infants. Table J shows

TABLE OF FREQUENCY VIII

SUB-OCCIPITO-BREGMATIC DIAMETER (IN CENTIMETERS) OF INFANTS AT BIRTH

CENTIMETERS	FREQUENCY		CENTIMETERS	FREQUENCY	
	Males	Females		Males	Females
7..........	0	3	10.5.......	36	32
7.5........	1	5	11.........	64	65
8..........	20	41	11.5.......	22	20
8.5........	44	52	12.........	10	8
9..........	320	363	12.5.......	6	3
9.5........	204	167	13.........	0	3
10.........	272	238	13.5.......	1	....
				1,000	1,000
Average.....	....	....	....	9.623	9.516
A.D........	....	....	....	.616894	.644561

the facts with respect to variability. Males are slightly larger on the average than females. Females are slightly more variable both absolutely and relatively. The range, including 100 per cent of

TABLE J

	Sex	Average (cm.)	A.D. (cm.)	Pearson Coefficient of Variation	P.E. of Pearson Coefficient	Thorndike Coefficient	Range Including 100 Per Cent of Cases	Unbroken Range
Sub-occipito-bregmatic diameter	Males	9.623	.616894	.0641	.0008	.199	7.5–13.5 (inc.)	7.5–12.5 (inc.)
	Females	9.516	.644561	.0677	.0008	.209	7–13 (inc.)	7–13 (inc.)

the cases, is 6 cm. for both sexes. There are 3 females smaller than the smallest male, and 1 male larger than the largest female. If we eliminate this one male who reached the exceptionally great diameter of 13.5 cm. the next largest infants are 3 females, who reached

a diameter of 13 cm. To compare previous results with ours see Table M.

Occipito-frontal (circumference).—Table of Frequency IX gives the complete distribution for the 2,000 infants. Table K shows the

TABLE OF FREQUENCY IX

OCCIPITO-FRONTAL CIRCUMFERENCE (IN CENTIMETERS) OF INFANTS AT BIRTH

CENTIMETERS	FREQUENCY		CENTIMETERS	FREQUENCY	
	Males	Females		Males	Females
28..........	0	3	35.........	161	128
28.5........	0	1	35.5.......	53	32
29..........	4	3	36.........	102	56
29.5........	2	3	36.5.......	19	12
30..........	18	17	37.........	31	10
30.5........	4	5	37.5.......	4	4
31..........	27	40	38.........	11	2
31.5........	13	22	38.5.......	1	0
32..........	66	116	39.........	2	0
32.5........	30	50	39.5.......	0	1
33..........	122	173	40.........	1	....
33.5........	63	83	40.5.......	0	....
34..........	199	187	41.........	0	....
34.5........	66	52	41.5.......	1	....
				1,000	1,000
Average.....	....	....	....	34.145	33.568
A.D........	....	....	....	1.27692	1.221676

facts with respect to variability. Males are on the average slightly larger than females. Males are slightly more variable absolutely.

TABLE K

	Sex	Average (cm.)	A.D. (cm.)	Pearson Coefficient of Variation	P.E. of Pearson Coefficient	Thorndike Coefficient	Range Including 100 Per Cent of Cases	Unbroken Range
Occipito-frontal (circumference)	Males	34.145	1.276920	.0374	.0005	.218	29–41.5 (inc.)	29–39 (inc.)
	Females	33.568	1.221676	.0363	.0005	.211	28–39.5 (inc.)	28–38 (inc.)

Relatively there is no reliable difference. The range, including 100 per cent of the cases, is 1 cm. greater for males. There are 4 females smaller than the smallest males, and 2 males larger than the largest

female. To compare these results with previous work see Table M.

Sub-occipito-bregmatic (*circumference*).—Table of Frequency X gives the total distribution of the 2,000 infants. Table L shows the

TABLE OF FREQUENCY X

SUB-OCCIPITO-BREGMATIC CIRCUMFERENCE (IN CENTIMETERS) OF INFANTS AT BIRTH

Centimeters	Frequency		Centimeters	Frequency	
	Males	Females		Males	Females
26..........	1	2	33..........	115	71
26.5........	0	0	33.5........	32	16
27..........	2	2	34..........	47	14
27.5........	1	3	34.5........	10	4
28..........	23	38	35..........	12	5
28.5........	10	17	35.5........	2	1
29..........	67	87	36..........	3	1
29.5........	24	39	36.5........	3	....
30..........	132	180	37..........	0	....
30.5........	71	81	37.5........	0	....
31..........	182	176	38..........	0	....
31.5........	59	85	38.5........	0	....
32..........	153	141	39..........	1	....
32.5........	50	37			
				1,000	1,000
Average.....	....	....	....	31.392	30.869
A.D........	....	....	....	1.299191	1.158162

facts with respect to variability. Males are on the average slightly larger than females. Males are more variable both absolutely and

TABLE L

	Sex	Average (cm.)	A.D. (cm.)	Pearson Coefficient of Variation	P.E. of Pearson Coefficient	Thorndike Coefficient	Range Including 100 Per Cent of Cases	Unbroken Range
Sub-occipito-bregmatic (circumference)	Males	31.392	1.299191	.0414	.0005	.232	26–39 (inc.)	27–36.5 (inc.)
	Females	30.869	1.158162	.0375	.0005	.209	26–36 (inc.)	27–36 (inc.)

relatively. The range, including 100 per cent of the cases, is greater for males by 3 cm. To compare these results with previous work see Table M.

Williams gives the following cranial measurements based on his own work and that of Riggs. In no case is there any statement of variability or indication of the reliability of the average. The number of cases on which the averages are based is also not stated. It

TABLE M

Diameters	Williams	Riggs
Occipito-frontal	11.75 cm.	11.71 cm.
Bi-parietal	9.25	9.25
Bi-temporal	8.00	8.00
Mental-occipital	13.5	13.33
Sub-occipito-bregmatic	9.5	9.70
Circumference		
Occipito-frontal	34.5 cm.	....

will be seen that the figures agree closely with ours, though on the whole our measurements run slightly smaller than those of either Holt or Riggs. Their figures are for both sexes taken indiscriminately.

INTERPRETATION

The facts, stated briefly, are as follows:

1. Male infants are on the average, without exception, slightly larger than female infants in all anatomical measurements. The difference is, however, much less than we had expected to find, and is in most cases so small as to be practically negligible.

2. If we take the gross A.D. as the measure of comparative variability, we find that in 6 cases the males are more variable; in 4 cases the females are more variable.

3. If we take the Pearson Coefficient as the measure of variability, we find that in 6 cases there is no difference in variability, when the P.E. of the coefficient is computed; in 3 cases the females are slightly more variable; in 1 case the males are slightly more variable.

4. If we take the Thorndike Coefficient as the measure of variability, in 3 cases the males are more variable; in 3 cases the females are more variable; in 4 cases the variability is the same.

5. In all cases the differences in variability are very slight. In only 2 cases does the percentile variation differ in the first decimal

place. In these 2 cases the variability is once greater for males and once greater for females.

6. The range, including 100 per cent of the cases, is slightly greater for males in 4 cases; slightly greater for females in 2 cases; equal in 4 cases.

7. The unbroken range is greater for males in 2 cases; greater for females in 2 cases; equal in 6 cases.

Table N shows all these results in final tabular form. The great number of cases, and the fact that the number of cases in each group is equal, make these results very reliable. The chances are almost negligible that the findings would be changed if an infinite number of cases were included. The facts adduced lend no support whatever to the theory that males are inherently more variable than females. Whichever figure we take as the measure of variability, there is no indication of any real sex difference for the anatomy as a whole. It is true that *in cranial measurements* females are very slightly more variable on the whole, both relatively and absolutely, in spite of their slightly smaller central tendency, and this fact is especially interesting in view of the statement by Ellis[1] that, "as might be anticipated, the greater variability of men in mental capacity is, on the anatomical side, connected with a greater variability in the size of the skull and brain."

It is notable that greater range coincides with a greater A.D. only 3 times out of a possible 10; and with a greater coefficient of variation only 2 times out of 10. This is interesting, as with two groups as large as these, identical in number, the empirical results should show greater variation and greater range in coincidence in the majority of possible cases, if anatomical traits conform to the Gauss curve of probability.

It is a matter of incidental interest that a ratio of about 2 to 1 holds in nearly all of the traits, for largest to smallest infant. Table O shows these ratios for the sexes separately. The greatest difference between largest and smallest infants is found in the case of weight, where the ratio is almost 3 to 1 for females, and 2.5 to 1 for males.

[1] H. Ellis, *op. cit.*, p. 366.

TABLE N

Summary of Results

Trait	Sex	Average	A.D.	Pearson Coefficient of Variation	P.E. of Pearson Coefficient	Thorndike Coefficient of Variation	Range Including 100 Per Cent of Cases	Unbroken Range
Weight	Males	3,357.65 gm.	397.3824	.1183	.0014	.685	2,030–5,020 (inc.)	2,430–4,350 (inc.)
	Females	3,221.17 "	381.0768	.1183	.0014	.671	1,960–5,000 "	2,270–4,250 "
Length	Males	50.51 cm.	2.349	.0465	.0006	.330	38–62 "	40–59 "
	Females	49.90 "	2.275	.0456	.0006	.323	35–59 "	40–59 "
Shoulders (circumference)	Males	34.143 "	1.9069	.0558	.0007	.326	26–45 "	26–43 "
	Females	33.823 "	1.8870	.0558	.0007	.324	25–45 "	25–42 "
Bi-temporal	Males	7.558 "	.7188	.0951	.0012	.262	5–10 "	5–10 "
	Females	7.469 "	.7226	.0967	.0012	.264	5–10 "	5–10 "
Occipito-frontal (diameter)	Males	11.358 "	.5962	.0525	.0006	.177	9–15 "	9–14 "
	Females	11.177 "	.5907	.0529	.0006	.177	8.5–14 "	8.5–14 "
Bi-parietal	Males	8.886 "	.5014	.0564	.0007	.169	6–11.5 "	6–11.5 "
	Females	8.784 "	.5404	.0615	.0008	.182	6–11 "	6–11 "
Occipito-mental	Males	12.990 "	.8040	.0619	.0008	.223	8–15.5 "	8–15.5 "
	Females	12.773 "	.8323	.0651	.0008	.233	8–15.5 "	8–15.5 "
Sub-occipito-bregmatic (diameter)	Males	9.623 "	.6169	.0641	.0008	.199	7.5–13.5 "	7.5–12.5 "
	Females	9.516 "	.6446	.0677	.0008	.209	7–13 "	7–13 "
Occipito-frontal (circumference)	Males	34.145 "	1.2769	.0374	.0005	.218	29–41.5 "	29–39 "
	Females	33.568 "	1.2217	.0363	.0005	.211	28–39.5 "	28–38 "
Sub-occipito-bregmatic (circumference)	Males	31.392 "	1.2992	.0414	.0005	.232	26–39 "	27–36.5 "
	Females	30.869 "	1.1582	.0375	.0005	.209	26–36 "	27–36 "

Formula to get P.E. of Pearson Coefficient: $.6745 \times \frac{1}{\sqrt{3n}}$ of its value (see *Variation in Man and Woman*, p. 283).

The two phenomena that should appear if males are inherently more variable, i.e., (1) a more abrupt drop in the curve of the males, on the side of great size, to indicate greater pelvic selection, and (2) a preponderance of males at *both* extremes of the distribution,

TABLE O

Sex	Weight	Length	Shoulders	Bi-temp.	Occipito-frontal	Bi-parietal	Occipito-mental	Sub-occipito-bregmatic	Occipito-frontal	Sub-occipito-bregmatic (Circumference)
Male...	2.5–1	1.7–1	1.7–1	2.0–1	1.7–1	1.9–1	1.9–1	1.8–1	1.4–1	1.5–1
Female.	2.8–1	1.7–1	1.8–1	2.0–1	1.7–1	1.9–1	1.9–1	1.8–1	1.4–1	1.4–1

do not present themselves. The curves for females follow very closely the curves for males, and both taper out at the extremities in the same way. Among infants of exceptionally great size males predominate; among infants of exceptionally small size females predominate.[1]

CONCLUSION

It has happened not infrequently that greater mental variability has been inferred from alleged greater anatomical variability, and men have argued, in uncritical moments, from a more variable femur to a more variable literary ability. We wish to emphasize the fact that nothing is proved by this study of anatomy as to the *mental* variability of males and females. Our results, showing that there is no inherent difference in anatomical variability, suggest that there will be found to be no inherent difference in mental variability, but they do not *prove* that such is the case.

All manner of sex differences in deportment and achievements have been ascribed to alleged sex differences in variability, from the fact that women have not made notable scientific discoveries to the fact that they do not consume large quantities of alcohol. Alleged lesser variability among women has but shared with many other alleged causes the blame for women's failure to achieve intellectual

[1] We have presented the individual measurements of the twins, which were excluded from the distribution, so that it may be seen what would have been the effect on the distribution had they been included (see p. 368).

MEASUREMENTS OF TWINS

Mixed Twins

Length	Occipito-frontal	Bi-parietal	Bi-temporal	Occipito-mental	Sub-occipito-bregmatic	Occipito-frontal	Sub-occipito-bregmatic	Shoulders	Weight
F. 45...	9	7.5	6.5	11	9	29	30	31	2,400
M. 42...	10	7	5	11	7	30.5	27.5	25	1,760
F. 45...	9	9	6.5	11	10	30.5	29.5	30	2,080
M. 49...	10	9	7	11.5	10	33	30	32	2,890
F. 48...	9	8	7	11	9	30	28	31	2,250
M. 44...	10	8	7	11	8	31	29	27	1,950
F. 45...	7.5	5	9.5	9.5	8	29	27.5	26	1,500
M. 50...	11	9	9.5	13	10	34.5	32	34	2,700
F. 51...	11	7.5	6	12	9.5	37.5	30.5	33.5	2,900
M. 50...	11	9	6.5	13	9	32	30.5	33.5	2,700
F. 49...	10	6.5	5	10	9	31	29	32	2,680
M. 52...	10.5	7.5	7	9.5	9	32	29	33	2,460
F. 49...	11.5	9.5	7	13	10	32.5	31.5	31	2,660
M. 47...	11	9	8	12.5	9.5	32.5	30.5	29.5	2,300
F. 51...	11	10	8	12	10	34.5	31	34	2,970
M. 52...	12	10	8	11	10	34	32	33	3,070

Male Twins

51......	11	9	7	12	9	34	33	34	3,650
50......	11	9	7	12	9	35	33	35	3,470
50......	10.5	9.5	8.5	13.5	10	35.5	32	33	3,180
48......	10	8.5	7	12	9.5	32	30	30	2,840

Female Twins

48......	10	8.5	7.5	12	9	32	30.5	37	3,320
47......	11	8	7	11.5	9	32.5	30	34	3,000
48......	10	7	5	10	8	31	29	25	2,070
46......	10	8	6	10	8	31	26	26	1,880
49......	11	9.5	8.5	13	9.5	31	28	33	2,550
Died....	......	......	......	......	......	......	......	......	.....
44......	10	7.5	7	10.5	8.5	28	22	28	2,540
40......	8.5	6	5.5	9	6	22	17.5	22.5	2,210

MEASUREMENTS OF TWINS—*Continued*

FEMALE TWINS

Length	Occipito-frontal	Bi-parietal	Bi-temporal	Occipito-mental	Sub-occipito-breg-matic	Occipito-frontal	Sub-occipito-breg-matic	Shoulders	Weight
47......	11	9.5	6	11	9.5	33	30.5	30	2,350
49......	10.5	8.5	6	11	9.5	32.5	29.5	27.5	2,500
39......	9	7	5.5	8.5	7.5	26	24.5	23	1,450
38......	9	7	5.5	9	8	27	25.5	25	1,300
46	10.5	9.5	8.5	11.5	10	31	29	30	1,910
43......	10	8.5	8	11	9	30	29	25.5	1,670
43......	10.5	9.5	7.5	12	8.5	33	30	30	2,390
42......	10.5	9	8	11.5	9	32.5	29.5	28	2,120

eminence. Some of these are greater affectability, lesser brain weight, lesser general ability, lack of the fighting instinct. Men have apparently been willing to recognize as a cause of women's inferior attainment almost any factor except the most obvious and incontestable one, i.e., that they have borne and reared the young and men have not.

The few scattered and inadequate data at present accessible as to the comparative variability of the sexes in mental traits have been reviewed and criticized elsewhere by one of the present writers.[1] No experimental study for the express purpose of determining the variability of the sexes in mental traits has been made. The few figures available have come as incidental matter from studies which had some other main purpose in view. In the evidence, such as it is, no indication of greater male variability is found.

In view of the fact that the most accurate and comprehensive studies so far made of comparative anatomical variability of the sexes fail to reveal any sign of greater male variability, and since there is no experimental or statistical data extant which prove the greater mental variability of males, it would seem necessary to abandon greater male variability as an ingenious explanation of sex differences in achievement, and as the source of "social and practical consequences of the widest significance."

[1] Leta S. Hollingworth, *op. cit.*

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